INSULATION PRODUCT FROM ROTARY AND TEXTILE INORGANIC FIBERS AND THERMOPLASTIC FIBERS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation of the following copending U.S. patent applications: U.S. patent application Serial No. 09/946,474, filed on September 6, 2001; U.S. patent application Serial No. 09/946,476, filed on September 6, 2001; U.S. patent application Serial number 10/689,858, filed on October 22, 2003; U.S. patent application Serial No. 10/766,052, filed on January 28, 2004; U.S. patent application Serial No. 10/781,994, filed on February 19, 2004 for FORMALDEHYDE-FREE DUCT LINER; and U.S. patent application Serial No. 10/782,275, filed on February 19, 2004 for INORGANIC FIBER INSULATION MADE FROM GLASS FIBERS AND POLYMER BONDING FIBERS, which are commonly assigned and hereby incorporated by reference.

[0002] This application is also related to U.S. Patent No. 6,673,280, issued on January 6, 2004.

FIELD OF THE INVENTION

[0003] The present invention relates to fiber glass insulation product and more particularly to an insulation product made from scrap rotary glass fibers and scrap nylon fibers reinforced with a small amount of scrap textile glass fibers.

BACKGROUND OF THE INVENTION

[0004] Conventional fiber mats or webs used for thermal and acoustic insulation are made either primarily from textile fibers, or from rotary or flame attenuated fibers. ToughGard^{TM} ductliners manufactured by CertainTeed Corporation of Valley Forge, Pennsylvania is an example of insulation products made primarily from textile fibers. Textile fibers used in thermal and acoustic insulation are typically chopped into segments 2 to 15 cm long and have diameters of greater than 5 microns up to 16 microns. Rotary fibers and flame attenuated fibers are relatively short, with lengths on the order of 1 to 5 cm, and relatively fine, with diameters of 2 to 5 microns. Mats made from textile fibers tend to be stronger and less dusty than those made from rotary fibers or flame attenuated

fibers, but are somewhat inferior in insulating properties. Mats made from rotary or flame attenuated fibers tend to have better thermal and acoustic insulation properties than those made from textile fibers, but are inferior in strength.

[0005] Thus, a need exists for new, low cost fiber products with a satisfactory combination of insulation, strength and handling characteristics.

SUMMARY OF THE INVENTION

[0006] According to an aspect of the present invention, thermal and acoustical fiber composite insulation product made from rotary and textile glass fibers, thermoplastic fibers, and at least one binder is disclosed.

[0007] In a preferred embodiment of the present invention, the rotary glass fibers and the textile fibers may be scrap, virgin or a mixture of virgin and scrap fibers. Scrap rotary fibers may be, for example, scrap building insulation and/or metal-building insulation. Scrap thermoplastic fibers may be, for example, scrap nylon carpet fibers. A small amount of textile fibers is added to the fiber blend to provide reinforcement because textile fibers have higher tensile strength than the rotary fibers. The blend of the three fibers are bound together with at least one binder into an insulation mat or batt. The binder may be a thermosetting resin binder or a thermoplastic binder in liquid or powdered form.

[0008] In another embodiment of the present invention, a method of making a fiber glass insulation product is disclosed. Rotary glass fibers, thermoplastic fibers, and the textile fibers provided in bulk form, such as bales, along with the powdered or liquid binder are opened and blended. The fibers are then evenly spread on to a surface into a fibrous mat which is then cured or heated to form the final insulation mat. Generally, a facing layer, such as a non-woven, kraft or polyethylene film, is applied to at least one side of the mat before curing or heating the fibrous mat.

[0009] The preferred use of the scrap nylon fibers along with scrap glass fibers reduces manufacturing cost. Additional cost savings may also be realized by eliminating the manufacturer's disposal cost of scrap fibers. In addition, recycling of the scrap fibers provides an environmentally friendly alternative to discarding the scrap fibers in landfills. The blend of scrap rotary fibers, scrap thermoplastic fibers and scrap textile fibers used in

the present invention also produces an insulation product having equivalent insulation property as the conventional textile fiber-based insulation products. Thus, the present invention provides a fiber glass insulation product that is less expensive than the conventional textile fiber-based insulation product but having an equivalent insulation property without much sacrifice on its strength.

[0010] In a further embodiment, a thermal and acoustical insulation product is made from a blended mixture of rotary and textile glass fibers, thermoplastic fibers and resinous binder. The rotary and textile glass fibers are bonded together by the combined adhesion caused by heating the blended mixture whereby the thermoplastic fibers and the resinous binder are disposed at least partially in molten state and thereafter cooling said heated blended mixture to ambient temperature to form the insulation product.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIGURE 1 is a schematic illustration of a cross-sectional view of an exemplary glass fiber insulation according to an embodiment of the present invention.

[0012] FIGURE 2 is a schematic diagram illustrating a process for fabricating an insulation product from rotary and nylon scrap fibers according to an embodiment of the present invention.

[0013] FIGURE 3 is a flow chart diagram of a process for fabricating the insulation product according to an embodiment of the present invention.

[0014] FIGURE 4 is an enlarged view of a portion of the glass fiber insulation.

[0015] The features shown in the above referenced drawings are not intended to be drawn to scale nor are they intended to be shown in precise positional relationship. Like reference numbers indicate like elements.

DETAILED DESCRIPTION OF THE INVENTION

[0016] FIGURE 1 is a cross-sectional view of a thermal and acoustical insulation product **100**, according to a preferred embodiment of the present invention. The insulation product **100** comprises a fibrous insulation mat **120** having a first side **121**, a second side **122** and a non-woven facing layer **130** bonded to the first side **121**. The fibrous insulation mat **120** has a density of about 16 to 56 kg/m^3 (1.0 to 3.5 pounds per

cubic feet (pcf)) and preferably about 24 to 48 kg/m^3 (1.5 to 3.0 pcf). The gram weight of the fibrous insulation mat **120** is in the range of about 530 to 3750 gm/m^2 and preferably about 700 to 3300 gm/m^2. The thickness of the insulation product **100** may be fabricated to be in the range of about 10 to 200 mm (about 0.5 to 8.0 inches) and preferably about 10 to 50 mm (about 0.5 to 2.0 inches).

[0017] Figure 4 is a schematic illustration of a more detailed view of the bonded fiber matrix in the thermal and acoustical insulation product **100** of Figure 1. The illustration depicts the preferred nature of the resinous bonds in the insulation product of the present invention. The rotary glass fibers **210** and textile glass fibers **240** are bonded together by the combined adhesion produced by heating the blended mixture of the fibers that includes thermoplastic fibers **220** and the resinous binder. In the heated state, the thermoplastic fibers **220** partially melt and form fiber-to-fiber melt bonds **301** directly between the thermoplastic fibers **220** and any other fiber that is in contact with the thermoplastic fibers at the intersection point of the two fibers (i.e. rotary fiber-to-thermoplastic fiber; textile fiber-to-thermoplastic fiber; and thermoplastic fiber-to-thermoplastic fiber) after the blended fiber mixture is cooled to ambient temperature. The resinous binder forms adhesive bonds **302** between any set of fibers that may be in contact or near each other. The melt bonds **301** formed by the thermoplastic fibers supplement the adhesive bonds **302** formed by the resinous binder.

[0018] In a preferred embodiment of the present invention, the fibrous insulation mat **120** may be fabricated from inorganic fibers, such as glass fibers comprising rotary fibers and textile fibers, thermoplastic fibers and at least one binder. All of the fiber materials may be scrap fibers to minimize the raw material cost.

[0019] The rotary glass fibers may have an average diameter of about 3 to 5 microns and preferably between 4 and 5 microns. The rotary glass fibers have an average length of less than about 100 mm (about 4 inches) and preferably less than about 75 mm (about 3 inches). In a preferred embodiment of the present invention, the rotary glass fibers may be scrap fibers, such as, for example, scrap building insulation batts or blown insulation fibers.

[0020] Textile glass fibers, which may preferably be scrap textile fibers, enhance the strength of the final insulation product. The textile fibers may have an average

diameter of about 6 to 20 microns and average fiber length of about 13 to 130 mm (about 0.5 to 5 inches). The total glass fiber content of the insulation product of the present invention may be about 30 to 50 wt. % of the fibrous insulation mat **120** and the textile fiber content is preferably less than about 20 wt. % of the total glass fiber content of the final insulation product.

[0021] The thermoplastic fibers, which may also preferably be scrap fibers, used in the insulation product of the present invention may comprise about 30 to 50 wt. % of the final insulation product. The thermoplastic fibers are about 20 to 50 micrometers in diameter. The thermoplastic fibers are about 6 to 130 mm (about 0.25 to 5 inches) and preferably about 13 to 102 mm (about 0.5 to 4 inches) in length. Thermoplastic fibers made from thermoplastic resins which melt or form a melt adhesive bond with glass fibers at the same time and temperature that the resinous binder cures or melts (whether the resinous binder is cures or melts depends on whether the resinous binder is a thermoplastic type or a thermosetting type), are preferred. Such resins include nylon, acrylics, olefins, such as polyethylene and polypropylene, polyacryl ether, polyallomer, polysulfone, polyethersulfone, polyphenylene oxide, and polyvinyl chloride, for example. The thermoplastic fibers may be, for example, scrap nylon carpet fibers.

[0022] The fiber components are mixed with at least one resinous binder to make the insulation product of the present invention. The binder may be thermo-setting resin binders commonly used in the industry. Alternatively, thermoplastic powder binders may be used. Liquid and powdered binders are known and available for this use. See U.S. Patents No. 5,883,020 and 4,751,134, which are incorporated herein by reference.

[0023] In the exemplary embodiment of the insulation product **100** of FIGURE 1, a facing layer **130**, such as a kraft, polyethylene film ornon-woven, is bonded to the first side **121** of the insulation mat. Some examples of facing layer material are non-woven glass or resin fibrous mats, polyethylene film and glass fiber scrim. Depending on the final application of the insulation product, non-woven facing layer may even be applied to both sides of the insulation mat or encapsulate the insulation mat if necessary. But, generally, at least one side of the insulation mat has a facing layer, which may or may not contain a vapor barrier.

[0024] An exemplary process that may be employed in fabricating the insulation product according to an embodiment of the present invention will be described with reference to FIGURE 2. In this example, scrap rotary glass fibers **210** are fed on to a blending conveyor **40** from a first storage bin **12**. Scrap nylon fibers **220** are fed on to the blending conveyor **40** from a second storage bin **14**. The scrap textile glass fibers **240** are fed on to the blending conveyor **40** from a third storage bin **16**. Powdered resinous binder **250** (thermosetting resin or thermoplastic polymer) is then added to the mix of fibers on the blending conveyor **40** from a fourth storage bin **18**. The powdered resinous binder is added in a quantity to be about 5 to 35 wt% and preferably about 10 to 20 wt. % of the final insulation product.

[0025] Before the mixture of the fibers and the powdered binder can be made into a mat form, the mixture is preferably processed through a tearing apparatus **20**. The tearing apparatus **20** divides the fibers and evenly blends fibers and the powdered binder together. In the tearing apparatus **20**, fibers are torn into fiber segments between opposed rotating bars **22** with teeth. In another embodiment of the present invention, a rotary scrap mat may be used instead of preprocessed rotary scrap glass fibers. The tearing apparatus **20** would be configured to handle the rotary scrap mat also.

[0026] As the divided-fibers and binder mixture exits the tearing apparatus **20**, the mixture is evenly spread on to the surface of a forming conveyor **50** and formed into a fibrous mat **260** in a vacuum forming hood **32**. Additional fiber blending devices may be employed between the tearing apparatus **20** and the vacuum forming hood **32** to further blend the mixture and adjust the openness of the fibers if necessary. In the vacuum forming hood **32**, a vacuum is generally applied to the bottom of the forming conveyor **50** to pull the fiber/binder mixture against the forming conveyor **50** to form the fibrous mat **260**. The fibrous mat generally has a gram weight of about 530 to 3750 gm/m^2 and preferably about 700 to 3300 gm/m^2.

[0027] Generally, a glass fiber or other non-woven facing layer **91** is provided on the surface of the forming conveyor **50** so that the facing layer **91** bonds to the bottom side of the fiber mat during the subsequent curing or heating step. In another embodiment of the present invention, a second facing layer may be provided from a supply roll **90** on to the top side of the fiber mat before the mat enters the curing or

heating oven **34**. In other words, the facing layer **91** is applied to at least one of the two sides of the mat

[0028] The fibrous mat **260** is then transported by the forming conveyor **50** to the curing or heating oven **34**. In the oven **34**, the fibrous mat **260** is subjected to an elevated temperature appropriate for curing or heating the binder to fix the fibrous mat at a desired thickness and form a final insulation mat **280**. Whether the fibrous mat **260** is cured or just heated depends on the type of binder used, as thermoplastic binders do not cure. For a typical resin binder used in this application, e.g. phenolic resin binder, the curing temperature may be set about 200 to 270° C.

[0029] The final insulation mat **280** leaving the oven **34** may be cooled in a cooling station **36** and then sized and packaged for shipping. The thickness of the final insulation mat **280** may be fabricated to be in the range of about 10 to 200 mm (about 0.5 to 8.0 inches) and preferably about 10 to 50 mm (about 0.5 to 2.0 inches). However, the fiber glass composite insulation material of the present invention may be used for a variety of types of insulation products and the final thickness, density, and gram weight of a particular insulation product may be determined by the levels of acoustic and/or thermal insulation that are desired or necessary for a particular application.

[0030] The insulation mat of the present invention is optimally suited for insulation product applications such as building insulation batts, duct liners, industrial high density insulation products such as duct boards, and OEM insulation products.

[0031] FIGURE 3 illustrates a flow chart diagram of the exemplary process.

[0032] At step **500**, rotary fibers, nylon fibers, and textile fibers are fed on to a blending conveyor.

[0033] At step **510**, at least one binder (thermosetting resin binder or thermoplastic binder) is added to the fiber mixture on the blending conveyor.

[0034] At step **520**, the fiber/binder mixture is divided into smaller segments, opened, and evenly spread on to a forming conveyor.

[0035] At step **530**, optionally a non-woven facing layer may be applied to the forming conveyor surface first before the fiber/binder mixture is spread on to the forming conveyor in step **520**.

[0036] At step **540**, the opened and blended fiber/binder mixture is formed into a fibrous mat through a vacuum forming hood.

[0037] At step **550**, the fibrous mat is cured or heated in a curing or heating oven to form a final insulation mat having a desired thickness.

[0038] At step **560**, the final insulation mat may be cooled in a cooling station.

[0039] At step **570**, the cured insulation mat may be sized and packed for shipping.

[0040] While the foregoing invention has been described with reference to the above embodiments, various modifications and changes can be made without departing from the spirit of the invention. Accordingly, all such modifications and changes are considered to be within the scope of the appended claims.